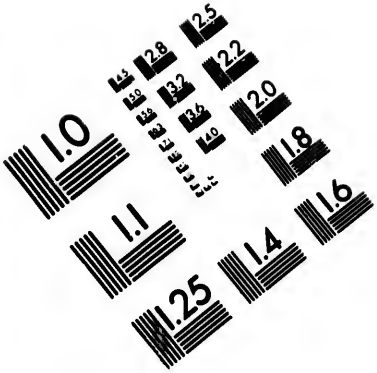


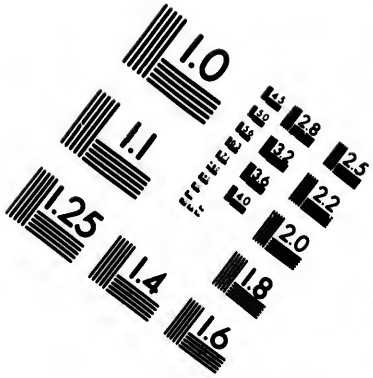
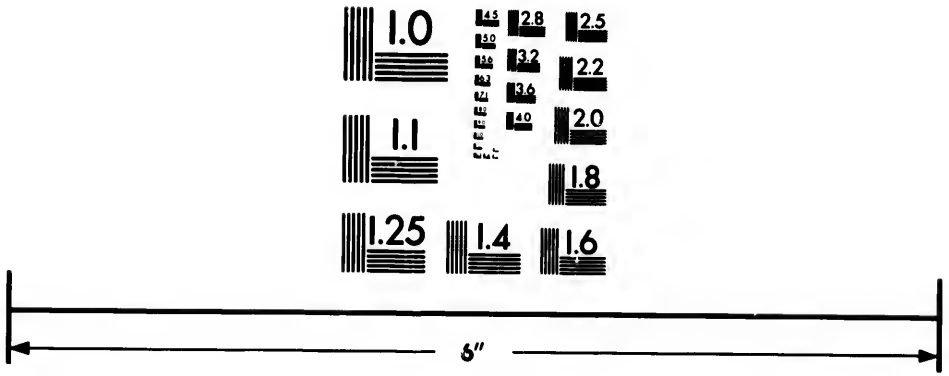
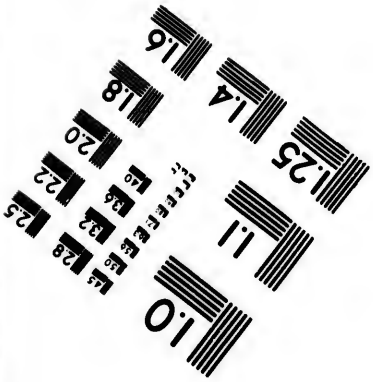
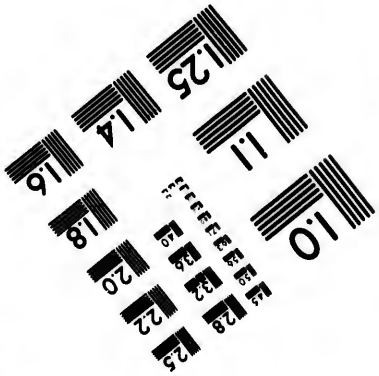


IMAGE EVALUATION TEST TARGET (MT-3)







Photographic Sciences Corporation

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

Technical and Bibliographic Notes/Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

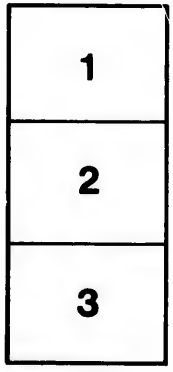
L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

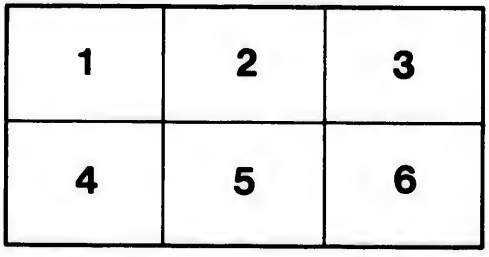
- [x] Coloured covers/ Couverture de couleur
- [ ] Covers damaged/ Couverture endommagée
- [ ] Covers restored and/or laminated/ Couverture restaurée et/ou pelliculée
- [ ] Cover title missing/ Le titre de couverture manque
- [ ] Coloured maps/ Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black)/ Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations/ Planches et/ou illustrations en couleur
- [x] Bound with other material/ Relié avec d'autres documents
- [ ] Tight binding may cause shadows or distortion along interior margin/ La reliure serrée peut causer de l'ombre ou de la distortion le long de la marge intérieure
- [ ] Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/ Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- [ ] Additional comments:/ Commentaires supplémentaires:

- [ ] Coloured pages/ Pages de couleur
- [ ] Pages damaged/ Pages endommagées
- [ ] Pages restored and/or laminated/ Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- [ ] Pages detached/ Pages détachées
- [x] Showthrough/ Transparence
- [ ] Quality of print varies/ Qualité inégale de l'impression
- [ ] Includes supplementary material/ Comprend du matériel supplémentaire
- [ ] Only edition available/ Seule édition disponible
- [ ] Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image/ Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible.

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X	12X	14X	16X	18X	20X	22X	24X	26X	28X	30X	32X
							✓				





[illegible] COALS

TESTS.

14 A

COMPOSITION AND USES.

BY EDWIN GILPIN, M.A., F.G.S.

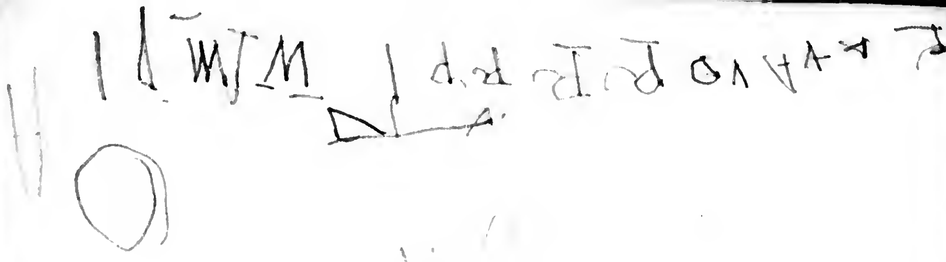
BY PERMISSION OF THE COUNCIL.

EXTRACT MINUTES OF PROCEEDINGS OF THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, VOL. XXVII., 1878.

Newcastle-upon-Tyne:

A. REID, PRINTING COURT BUILDINGS, ARENSIDE HILL.

1878.



CANADIAN COALS—THEIR COMPOSITION AND USES.

By EDWIN GILPIN, M.A., F.G.S.

THE writer having been engaged during the past year in an extensive investigation into the properties of the chief Nova Scotian coals, thought that a brief description of the more typical seams would not be without interest to the members of the Institute; and as there is but little known of the coal deposits of the rest of the Dominion beyond the reports of the officers of the Geological Survey, the writer has added a brief notice of the more modern coals of the North West Territory and British Columbia, showing the value of the coal interests of a portion of the Dominion which is gradually becoming appreciated as a suitable field for emigration.

The writer takes this opportunity of acknowledging his obligations to Mr. Selwyn, Director of the Geological Survey, for information about the British Columbia coals, to the managers of several of the Cape Breton Collieries, and to Mr. E. G. Millidge, the gentleman in charge of the Public Works in Cape Breton.

The chief available information relative to the composition of the Nova Scotian coals is found in the reports of the geological survey and scattered analyses made by various chemists. Unfortunately the value of these reports for comparison is materially affected by the various methods of analysis employed, by it being frequently left in doubt as to whether the coals were coked by a slow or fast application of heat, and by the fact that in many cases samples of the best portions of the seams were analysed, and the results given as averages of the whole bed. In the following set of analyses the samples were averages selected either from the pit heaps, from cargoes, or from the working face.

The writer would not presume to claim any greater accuracy for his own analyses, but considers this their chief value, that as the same method of analysis was applied to all, a better comparison can be made not only between individual seams but also between those of various districts.

In the following analyses the method pursued in the Laboratory of the Pennsylvania State Survey has been adopted, and is briefly as follows.

The moisture is determined by heating at 212 degrees for one hour, or until the sample ceases to lose weight. The percentage of volatile ingredients by fast coking is got by heating the coal in a loosely-covered platinum crucible until the gas flame ceases to be visible, then a nearly white heat is applied for about five minutes. The percentage of volatile matter by slow coking is got by raising the heat very gradually, and finally applying a nearly white heat as before.

The total sulphur is estimated by fusing one gramme of the coal with ten of carbonate of sodium, and six of nitrate of potassium, dissolving the fused mass in water acidulated by hydrochloric acid, and then evaporating to dryness; re-dissolving the residue in dilute hydrochloric acid, adding water and precipitating the sulphur by chloride of barium from the filtered solution. The sulphur present as sulphate of calcium is got by boiling with carbonate of sodium, and deducted from the total amount, and the necessary corrections made, for the sulphuric acid present in the carbonate of sodium. The ashes are got by the usual process.

In this paper the ton is invariably the long one of 2,240 lbs. The localities of the various seams and collieries will be found marked on the maps accompanying the papers contributed by the writer on the Pictou Coal-field, and the submarine coal of Cape Breton. The calculations of the theoretical evaporative powers of the fixed carbon and, for comparison with the results of the British naval steam-coal trials, got by Regnault's formula, although later researches have somewhat modified the values determined by him.

The following analyses of the Cape Breton coals have been arranged in descending order, in conformity with the results arrived at by the officers of the Geological Survey. Although this arrangement of the horizons of the various seams differs somewhat from that proposed by the writer and others, he thinks that the results of a survey extending over several years form the most reliable guide.

The following table shows the arrangement of the seams analysed in their supposed equivalency:—

Cow Bay District.			Glace Bay District.			Sydney District.		
Seam.	Thickness of Seams and Strata.	Colliery.	Seam.	Thickness of Seams and Strata.	Colliery.	Seam.	Thickness of Seams and Strata.	Colliery.
	Ft. In.			Ft. In.			Ft. In.	
...	... ...	...	Hub	9 8	Little Glace Bay	Crandal	4 9	...
Strata		...		366 3			320 3	
Block House	9 2	Block House	Harbour	6 2	Little Glace Bay	Victoria Sydney Main	6 0 6 0	Victoria Sydney
Strata	450 7	...	...	375 5	..		395 11	
Seam E.	3 2	.	Back Pit	4 9	...	No. 3.	4 0	...
Strata	118 0		...	112 9	..	..	116 4	..
McAulay	5 6	Gowrie	Phelan	8 0 9 6	Caledonian Reserve	Lingan Main	8 0	Lingan
Strata	215 10	..		188 3			126 6	..
South Head	7 9	South Head	Ross	4 6	Emery	Collins	4 10	Toronto

Hub Seam (of Little Glace Bay).—Although the land area of this seam is comparatively limited it is accessible under a large sea area.

Section.	Ft.	In.
Coal, good		10
,, soft		3
,, good	5	6
,, splint		1
,, good	3	0
Total ...	9	8

Being unable to procure samples of this coal, which is justly considered one of the best of the Cape Breton coals, the following analysis, by an unknown authority, is given :—

Volatile matter	33·21
Fixed carbon	63·94
Ash	2·85
	100·00

This coal is more particularly used for gas making, its yield for this purpose being 9,500 cubic feet of 15 candle gas per ton, and a good coke.

The slack which forms about one-fifth of the coal mined is suitable for blacksmiths' work, and has been used to a small extent for coke making.

HARBOUR SEAM (Stirling Pit).—This coal is also worked by the Little Glace Bay Co. The coal is laminated, with a pitchy lustre, some of the laminæ being dull and heavy; much mineral charcoal on the deposition planes; little visible pyrites. Primary planes at right angles to deposition planes, with films of white carbonate of lime and iron. Secondary planes inclined irregularly to primary, and to deposition planes at angles of 60 to 65 degrees without films of spar.

SECTION.	Ft.	In.
Coal, coarse		3
„ good	1	6
„ soft		1
„ good	3	4
Total	5	2

COMPOSITION.	Slow Coking.	Fast Coking.
Moisture	·80	·80
Volatile combustible matter	27·85	29·40
Fixed carbon	67·05	65·50
Ashes	4·30	4·30
	100·00	100·00
Theoretical evaporative power	9·19	8·98
Injurious sulphur	2·327	—
Specific gravity	1·29	—

Coke vesicular, hard, and bright; ash very light red; powder of coal deep chocolate red.

At one point in the workings of this seam the pit water contains an unusual quantity of the sulphate of iron.

The following are the gas values of this coal as determined during the present year :—

MONTREAL NEW CITY GAS COMPANY.		HALIFAX GAS COMPANY.	
Gas, cubic feet per ton	9,268	Gas, cubic feet per ton	9,700
Candle power	15·00	Candle power	14·75
Coke (good) bushels	40	Coke (very good) bushels	39

The coals from the Hub and Harbour Seams were tested some years ago at Halifax, on behalf of the Admiralty, by the chief engineer of the flagship, "Duncan." He reported that they both light up quickly, raise steam fast, and give a very moderate amount of clinker and ash. The Hub Seam gave 80·9, and the Harbour 83·5 per cent. of carbon, and that they are well adapted for use in Her Majesty's Navy.

BLOCK HOUSE SEAM.—Coal tolerably compact, with bright laminæ, a few being brown and shaley; no calc-spar films or visible pyrites;

primary and secondary planes cut each other, and deposition planes at angles 70 to 75 degrees; very little mineral charcoal on deposition planes, which are quite smooth.

Section.	Ft.	In.
Coal, top	1	0
„ good	3	9
„ „ (holing)		3
„ good	4	2
Total	9	2

The top coal is left for a roof as it is rather coarse.

Composition.	Slow Coking.	Fast Coking.
Moisture	·600	·600
Volatile combustible matter	29·480	31·580
Fixed carbon	65·565	63·465
Ashes	4·355	4·355
	100·000	100·000
Theoretical evaporative power	8·99	8·97
Injurious sulphur	2·63	—
Specific gravity	1·292	—

Coke partly coherent and vesicular; ash dark brick red.

The following analysis, made in 1871 by the Manhattan (New York) Gas Co., and the results of their tests, will show its good gas qualities :—

Gas, cubic feet, standard yield	9,500
„ „ „ maximum „	10,316
Candle power, standard „	16·53
Coke (1,460 lbs.) bus:	·40
Cubic feet purified by one bushel of lime	2,840

Analysis.	
Volatile matter	39·00
Fixed carbon	57·50
Ash	3·50
	100·00

The ultimate analysis was made at Halifax on behalf of the Admiralty.

Carbon	82·60
Hydrogen	4·79
Nitrogen	1·20
Oxygen	4·10
Sulphur	2·51
Ash	4·80
	100·00

The coal was tried on board H.M.S. "Garnet," and found to raise steam fifteen minutes quicker than any coal that had been supplied to the ship.

When mixed with twice its weight of Tillery Elled Welsh coal a saving of 12 per cent. over the Welsh coal alone was reported. The percentage of ash and clinker was very small. The only objection to its use in war vessels is the large amount of dense smoke given off when the fires are pushed.

The mine water has a powerfully corrosive action on the pumps which had to be lined with wood. The following analysis of it is by Mr. C. Hoffman, of the Geological Survey:—

CONSTITUENTS IN 1,000 PARTS OF THE WATER.

Suspended matter	·1510
Consisting of ferric oxide	·1052
*Sulphuric acid and organic matter	·0458
IN SOLUTION.	
Iron (as per-salt)	·2426
Iron (as proto-salt)	·1168
Manganese	·0078
Aluminium	·0420
Calcium	·1498
Magnesium	·0618
Potassium	·0134
Sodium	·1884
Silica	·0116
Sulphuric acid	1·4808
Chlorine	·4100
Phosphoric acid	traces
Organic matter	·2844
	3·0046

VICTORIA COAL SEAM.

SECTION.	Ft.	In.
Roof sandstone		
Coal, good	2	4
„ slatey		1
„ good	3	7
	6	0

Top-bench bright shining compact coal, primary and secondary planes irregularly inclined to each other, and to the deposition planes. Primary planes coated with a little calc-spar, deposition planes have a little mineral charcoal. The upper portion of the lower bench has a slightly splinty appearance, while the lower part resembles the upper bench, but is more lustrous, and has a cubical fracture. This coal contains a considerable amount of visible pyrites. In the more splinty portion of the seam it occurs in layers mixed with the mineral charcoal; and in the upper bench

* Combined with the ferric oxide as a basic sulphate of iron.

as small nodules. The whole appearance of the seam is very much in its favour; it is compact, and not liable to crumble. The coal has never been known to heat in cargo, but has done so when exposed in the slack heaps.

The specific gravity of the upper and lower benches is almost identical, the average being 1·290.

Composition.	Slow Coking.	Fast Coking.
Moisture	·28	·...
Volatile combustible matter	28·61	33·30
Fixed carbon	67·61	62·92
Ash	3·50	3·50
	100·00	100·00
Theoretical evaporative power	9·27	8·63
Injurious sulphur	2·84	—

Coke bright and vesicular; ash red, and inclined to form clinker.

The manager, Mr. J. Salter, writes—"We do not recommend the coal for gas, but find it well adapted for steam purposes." It has not been tried for coke, the slack sells readily for steam and smithy purposes.

Sydney Seam.—Bright compact coal, breaking irregularly, owing to the want of persistence of the secondary planes; little mineral charcoal; and visible pyrites; the primary planes have numerous films of carbonate of lime holding much carbonate of iron, which gives the weathered coal a rusty appearance.

Section.	Ft.	In.
Roof, arenaceous shale	—	
Coal, good	4	3
„ soft		2
„ good	1	9
Total	6	2

Composition.	Slow Coking.	Fast Coking.
Moisture	1·260	1·260
Volatile combustible matter	33·810	35·514
Fixed carbon	60·785	59·111
Ash	4·115	4·115
	100·000	100·000
Theoretical evaporative power	8·33	8·14
Injurious sulphur	1·705	—
Specific gravity	1·312	—

The average of four tests gave per ton—

Gas (cubic feet)	8,200
Candle power	8·00
Coke, good (lbs.)	1,295

The reputation of this coal is based chiefly on its suitableness for domestic purposes, and it commands a slightly higher price per ton than any other Cape Breton coals in the Halifax market. It is also used to some extent by the various steamers making Sydney a port of call. About one-eighth of the coal mined passes through a screen with bars three-quarters of an inch apart, and but little of it is saleable. After the coal has been banked out during the winter, one-fourth of it is in the state of slack.

The following is the result of a trial made of this coal by the American Government in 1844, and, as far as the writer is aware, it is the only practical trial that has been made of the evaporative power of any of the Cape Breton coals:—

Moisture	3·13	Lbs. of steam to one of coal from 212 degrees	7·90
Volatile combustible matter	23·81	Ash and clinker per cent. ...	6·00
Fixed carbon ...	67·57	Theoretical evaporative power	9·25
Ash	5·49		
	100·00		

From a comparison with the trials of Pictou coal made at the same place (see page 233), it will appear that the Pictou coals proved superior, although containing double the amount of ash.

The following table shows the composition of the ashes of the coals described above :—

	Block House.	Harbour.	Victoria.	Sydney.†
Iron Peroxide ...	45·621	63·355	56·543	51·33
Alumina	3·250	8·280	6·156	4·84
Insoluble silicious residue	35·110	21·872	27·500	29·57
Manganese	—	—	1·930	—
Magnesia	1·100	trace.	·035	·23
Lime	5·425	4·610	2·598	3·05
Sulphate of lime ...	—	—	—	10·98
Sulphuric acid ...	6·750	2·126	3·790	—
Phosphoric acid ...	1·900	·514	·691	trace.
‡Alkalies	trace.	trace.	·150	trace.
Chlorine	—	trace.	—	trace.
	99·156	100·787	99·693	100·00

The second seam that is worked to any extent, and which may be distinguished as the Phelan Seam is also known as the McAulay and Lingan Main.

* Theoretical evaporative power from Regnault's formula.

† Analysis by Dr. H. How.

‡ In this and the following analyses the alkalies were estimated only when they appeared to be present in quantity.

McAulay Seam (of Cow Bay).—Coal black, with faint greyish tinge. On fresh surfaces the lustre is bright and pitchy, with very fine laminæ of jet-like coal, and a good deal of mineral charcoal on the deposition planes. This coal sometimes exhibits four cleavage planes. The two primary ones are at right angles to each other and the deposition planes. The secondary planes are nearly at right angles to the deposition, and inclined to the primary planes at angles of 70 and 85 degrees. The primary planes have numerous films of calc-spar up to one-fourth of an inch thick; hardly any visible pyrites. Coal tolerably compact with nearly black powder.

Section.	Ft.	In.
Roof, arenaceous shale	—	
Coal (roof), coarse		6
„ good	1	0
„ soft, with considerable sulphur		6
„ good		9
„ splint		1
„ good	2	8
	5	6

Floor sandstone.

The roof coal is stowed in the mine.

Composition.	Slow Coking.	Fast Coking.
Moisture	·50	·50
Volatile combustible matter	28·13	31·41
Fixed carbon	66·01	62·73
Ash	5·36	5·36
	100·00	100·00
Theoretical evaporative power	9·05	8·62
Injurious sulphur	2·718	—
Specific gravity	1·310	—

Coke partly coherent; ash purplish red.

This coal has been used lately chiefly for steam and domestic purposes, and has proved a fair gas coal. It lights readily, and forms an easily managed fire, having very little effect on furnace bars. It was for several years used in considerable quantity at some American copper works, and formed a satisfactory fuel. The water from this seam has a corrosive action on the pumps, and is said to be similar in composition to that already noticed as found in the workings of the Block House seam in the same district.

In the retorts of the New York Gas Co., this coal yielded per ton—

Gas (cubic feet)	9,000
Candle power	15·00
Coke, good (lbs)	1,230
Gas purified by one bushel of lime	2,100

PHELAN SEAM (Caledonian Colliery).—The coal on the west side of the pit is moderately compact, with bright pitchy lustre, much mineral charcoal, and no visible pyrites. The secondary planes are inclined to the primary and deposition planes at angles of 65 and 75 degrees, causing the coal to break in rhomboidal forms. The primary planes have abundant films of calc-spar, with carbonate of iron and sulphate of lime. The coal on the east side is not so bright, and has a little visible pyrites, but no calc-spar films.

SECTION.	Ft. In.	Ft. In.
Roof, fire-clay	8	—
Coal (roof), coarse	—	1 8
,, good	—	3 6
Fire-clay	—	2
Coal, good	—	1 6
		6 10

Floor, hard arenaceous fire-clay.

COMPOSITION OF COAL FROM WEST SIDE OF PIT.

	Slow Coking.	Fast Coking.
Moisture	·40	·40
Volatile combustible matter	27·16	28·85
Fixed carbon	62·62	61·03
Ash	9·82	9·72
	100·00	100·00
Theoretical evaporative power	8·58	8·19
Injurious sulphur	·785	—
Specific gravity	1·270	—

Coke partly coherent and soft; ash light grey.

COMPOSITION OF COAL FROM EAST SIDE OF PIT.

	Slow Coking.	Fast Coking.
Moisture	·921	·921
Volatile combustible matter	28·625	30·312
Fixed carbon	64·021	62·334
Ash	6·433	6·433
	100·000	100·000
Theoretical evaporative power	8·78	8·62
Injurious sulphur	1·105	—
Specific gravity	1·330	—

Coke vesicular and soft; ash greyish white.

This coal is exported to the New England States chiefly for gas and steam purposes.

During the present year it yielded, at the Montreal Gas Works, per ton—

Gas, cubic feet	8,900
Candle power	14·25
Coke, bushels (fair)	36

RESERVE COLLIERY.—The Phelan seam, as worked at this colliery, presents no strong points of difference, except that some of the laminæ are of a highly lustrous jet black colour, which makes it form one of the handsomest of the Cape Breton coals.

SECTION.

	Ft.	In.
Roof, soft blue shale	—	
Coal roof	3	0
Soft blue shale		6
Coal, good	6	0
	9	6
Floor fire-clay.		

COMPOSITION.

	Slow Coking.	Fast Coking.
Moisture	·52	·52
Volatile combustible matter	34·21	37·60
Fixed carbon	59·73	56·34
Ash	5·54	5·54
	100·00	100·00
Theoretical evaporative power	8·19	7·86
Injurious sulphur	1·252	—
Specific gravity	1·280	—

Coke vesicular; ashes light, and of greyish brown colour.

The following ultimate analysis of this coal was made at the Royal School of Mines, London:—

Carbon	77·41
Hydrogen	5·47
Oxygen } Nitrogen }	9·30
Sulphur	2·47
Water	1·00
Ash	4·35
	100·00

The following is its gas yield in New York:—

Gas, cubic feet, per ton	9,500
Candle power	13·17
Coke, 40 bushels of 38 lbs.	1,520
Gas purified by one bushel of lime	2,380

LINGAN MAIN SEAM.—This coal is very similar in appearance to that worked at the Reserve Colliery, but is more compact, and with a considerable amount of visible pyrites.

SECTION.	Ft.	In.
Coal, good	1	2
„ pyritous		2
„ good		11
Fire-clay		1
Coal, good	5	8
	8	0

COMPOSITION.	Slow Coking.	Fast Coking.
Moisture	·75	·75
Volatile combustible matter	34·61	37·26
Fixed carbon	61·39	58·74
Ash	3·25	3·25
	100·00	100·00
Theoretical evaporative power	8·42	8·00
Sulphur	1·356	—
Specific gravity	1·298	—

Coke vesicular and hard; ashes light grey, with tinge of red.

This coal has been used chiefly for gas-making; it is also a fair house coal.

The following are its gas values in New York:—

Gas, cubic feet, per ton	9,520
Candle power	12·92
Coke (lbs.)	1,450
Gas purified by one bushel of lime	2,200

Its slack is well adapted for blacksmiths' work, and is said to have been successfully tried for coke.

The results of an analysis of the seams described above is shown in the subjoined table. The analysis of the ash of the Lingan main seam is by Dr. H. How, and taken from a paper communicated by him to the Chemical Society of London:—

	COLLIERY.	Fe_2O_3, Al_2O_3, S_2O_2,	CaO.	MnO,	SO_3,	NaK,	MgO,	PO_4,	Cl.	Total.
	Caledonia	11·853	4·200	65·734	7·151	·950	4·283	2·15	1·260	2·725	trace	100·306
	Reserve	21·810	8·110	68·330	·915	—	·480	trace	trace	trace	—	99·645
Lingan.	Top	35·660	9·070	43·070	6·130	not mentioned.	5·730	—	·34	—	—	100·000
Lingan.	Middle	1·570	6·080	79·460	8·840	not mentioned.	3·08	—	·97	—	—	100·000
Lingan.	Bottom	27·750	4·910	48·620	11·830	not mentioned.	6·52	—	·37	—	—	100·000
Lingan.	Average whole seam	21·66	6·690	57·050	8·930	not mentioned.	5 11	—	·56	—		100·000

The following is the lowest of the seams worked to any extent. The coals from it have not been long enough in the market to acquire any decided status for gas, steam, etc.

South Head Steam (Cow Bay).—Coal compact and not very bright; laminated, with a splinty appearance, and a few very thin layers of soft shaley coal. No mineral charcoal on the deposition planes, which are quite smooth. A little visible pyrites.

Section.

	Ft.	In.
Roof, strong shale	—	
Coal, good	1	8
Clay parting	0	1
Coal, good (two partings)	1	8
Coal, good	2	6
Coal, cannoloid	1	10
	7	9

Floor, hard arenaceous fire clay.

Composition.

	Slow Coking.	Fast Coking.
Moisture	1·767	1·767
Volatile combustible matter	28·000	28·833
Fixed carbon	62·263	61·430
Ash	7·970	7·970
	100·000	100·000
Theoretical evaporative power	8·53	8·12
Injurious sulphur	2·641	—
Specific gravity, average	1·382	—

Coke firm and compact; ash bulky, light reddish grey.

The appearance and composition of this coal is in favour of its being a good steam coal, and it has never been known to heat in cargo. It makes a marketable coke, and is said to have yielded 8,000 cubic feet of sixteen candle gas per ton from sample cargo.

Ross Seam (Emery Colliery).—Coal compact, laminated and lustrous, with much mineral charcoal on the deposition planes. The primary and secondary planes cut each other at right angles, giving the broken coal a cubical form. The partings have no films of calc-spar, and the coal shows no pyrites.

Section.

	Ft.	In.
Roof, hard grey sandstone	—	
Coal, good	1	2
Hard blue shale		0½
Coal, good	1	10
Hard, blue shale		0½
Coal, good	1	5
	4	6

Floor, fire clay.

Composition.	Slow Coking.	Fast Coking.
Moisture	·65	·65
Volatile combustible matter ...	32·21	31·80
Fixed carbon	63·49	60·90
Ash	3·65	3·65
	100·00	100·00
Theoretical evaporative power ...	8·70	8·25
Injurious sulphur ..	2·41	—
Specific gravity	1·287	—

Coke hard and vesicular; ash purplish red.

The composition of the ash of this coal is as follows:—

Iron peroxide	38·764
Alumina	1·336
Silicious residue	50·673
Lime	1·200
Manganese	trace.
Magnesia	1·015
Sulphuric acid	1·030
Phosphoric acid	·012
Chlorine	decided trace.
Alkalies	"
	100·030

On examining the ashes taken for the above analysis, two small rounded pear-shaped silicious pebbles were found, from one-fifth to one-third of an inch in diameter. When a quantity of the coal was roughly pulverised several more were found which appeared to be associated with a layer of the coal which presented a dull and shaley appearance.

The ultimate composition of this seam as worked at the Schooner Pond Colliery is—

Carbon	78·10
Hydrogen	5·18
Oxygen and Nitrogen	7·81
Sulphur	2·49
Water	2·67
Ash	3·45
	100·00

Collins Seam (Little Bras D'or).—This is a bright, tolerably compact coal, very similar to the Sydney seam in appearance, but has numerous very fine laminæ of slate.

Section.	Ft.	In.
Coal, top	2	6
" good	2	4
	4	10

Composition.	Slo Coking.	Fast Coking.
Moisture	1·983	1·983
Volatile combustible matter	26·156	30·896
Fixed carbon	66·482	61·712
Ash	5·379	5·379
	100·000	100·000
Theoretical evaporative power ...	9·10	8·43
Injurious sulphur	4·218	—
Specific gravity	1·311	—

Coke dense and hard; ash purplish red.

The proprietors claim that this coal is equal to any found in the island for gas and steam purposes, but the writer is in possession of no positive information as to its qualities.

The foregoing analyses show that, theoretically speaking, there is a great uniformity in the composition of the coal seams of this district, and this is borne out in practice, the chief differences being in the yield of gas and their coking values. As far as can be ascertained, they are all about on a par as steam coals, and all yield a fair domestic fuel. It is to be regretted that with the exception of the Sydney main seam no systematic trials have ever been made of their evaporative powers.

At Port Hood, on the western shore of the island, where several seams are exposed, a small colliery has been recently opened on one of them, which, it is said, has a thickness of six feet.

Coal tolerably compact, lustre moderate; very much pyrites in bands, and small nodules; a little mineral charcoal, but no calc-spar; primary planes at right angles to bedding; secondary almost entirely wanting, giving the coal a smooth fracture one way, and an uneven one across.

Composition.	Slow Coking.	Fast Coking.
Moisture	2·535	2·535
Volatile combustible matter	29·815	31·652
Fixed carbon	61·923	60·086
Ash	5·727	5·727
	100·000	100·000
Theoretical evaporative power ...	8·49	8·23
Sulphur	5·54	—
Specific gravity	1·277	—

Coke pulverulent; ash light red.

The writer is not aware that the coal possesses any special quality recommending it for the market, and the amount of sulphur present will prove a serious drawback.

At Broad Cove and Mabon there is an interesting exposure of the productive coal measures. The coals, although found in the regular or true coal-bearing strata, seem—from the large amount of moisture, and from their colouring action on a solution of potassium hydrate—to approach in character brown coals of a later age.

The following analysis is of a crop sample from one of the seams at Broad Cove, 5 feet 3 inches thick.

Coal tolerably compact, of a lustrous black colour, and laminated; primary and secondary planes irregular; with a little visible pyrites. When boiled in a solution of potassium hydrate it gives a brownish yellow colour. Powder blackish brown.

Composition.	Slow Coking	Fast Coking
Moisture	7·21	7·21
Volatile combustible matter	25·75	32·43
Fixed carbon	56·86	50·18
Ash	10·15	10·15
	100·00	100·00
Theoretical evaporative power	7·61	6·87
Sulphur	1·115	
Specific gravity	1·290	

Coke partly coherent: ash reddish brown.

The Report of the Geological Survey of Canada, dated May, 1873, gives analyses of several of the Broad Cove seams, from which it appears that they are fairly represented in the above analysis, except in the amount of ash, which is larger than that given in the report. In one of the seams layers of zinc blende were found, the first known instance of its occurrence in Nova Scotia coals.

As yet no openings of any amount have been made in these seams, and their practical values cannot yet be given.

The percentages of moisture are, however, a serious drawback. Taking the case of the coal analysed above, there would be no less than 162 lbs. of water in every ton. The results of this are that a large amount of carbon is diverted from its legitimate action on the water in the boiler to the task of evaporating the water contained in itself, and the weight of the fuel is increased in proportion to the percentage of efficient carbon.

THE PICTOU COAL-FIELD.

The Report of the Geological Survey of Canada for 1868, contains so full and careful a set of analyses of the Pictou coals, by the late Mr. Hartley, that the writer would not have added the following results, were it not that nearly ten years have elapsed since the report was published,

during which time fresh winnings have been opened out, and the faces of the old mines greatly advanced.

Pictou Main Seam.—As worked at the Foord pit of the Halifax Company.

Coal compact, bright, and somewhat irregularly laminated with uneven to sub-conchoidal fracture; much mineral charcoal on deposition planes; primary planes well defined, with films of calc-spar; secondary planes generally not well defined, and inclined to primary and deposition planes at angles of 70 and 80 degrees; no visible pyrites.

No recent measurement of this seam being available, the section passed through during the sinking of the pit is given.

Section.

	Ft.	In.
Coal, coarse	1	4
„ good	4	4
Ironstone band		2
„ good	20	6
„ coarse...	8	4
	34	8

This section changes slightly in various parts of the workings. The thick coal has two partings of ironstone balls, from two to ten inches thick, to be noticed further on. A carefully averaged sample gave:—

Composition.

	Slow Coking.	Fast Coking.
Moisture	1·05	1·05
Volatile combustible matter	26·19	27·42
Fixed carbon	63·41	62·18
Ash	9·35	9·35
	100·00	100·00
Theoretical evaporative power	8·68	8·49
Injurious sulphur	1·480	—
Specific gravity	1·310	—

Coke hard and compact; ash light grey.

The coal from this seam has for many years been extensively used for gas-making at Boston and Halifax. The following is a recent report on gas values.

Gas, cubic feet, per ton	7,280
Candle power	15·00
Coke, lbs. (fair quality)	1,325

Coal, very free from sulphur and not liable to heat.

The coke from this seam has now been practically tested at the Londonderry Ironworks with satisfactory results. (See page 9 of my paper on Nova Scotia Iron Ores.)

Analyses of Coke—Main Seam.	I.* 1876.	II. 1877.
Moisture	1·46	·55
Carbon	82·12	83·61
Sulphur	·62	·32
Phosphoric acid	—	·02
Ash	15·50	15·50
	100·00	100·00

The following analyses are of ironstone balls found in the main seam, and of a black band ironstone immediately overlying the deep seam, and occurring in bands having a thickness, it is stated, of two to five inches:—

	Clay Ironstone Balls. I.	Clay Ironstone Balls. II.	Black Band. I.
Moisture ...	2·132	·431	·732
Iron protoxide	45·361	39·630	36·000
Alumina ...	16·962	15·000	3·180
Silicious residue	·780	2·480	16·516
Lime	trace	3·580	3·780
Magnesia	1·655	4·980	·783
Manganese	trace	trace	4·450†
Sulphur	·612	·600	·214
Phosphoric acid	decided trace	·307	·586‡
Carbonaceous matter	not estimated	·510	6·110
Carbonic acid, etc.	not estimated	32·482	27·589
		100·000	100·000
Metallic iron	35·00	30·81	28·00

Clay Ironstone.—Black and brown colour, with bands of dirty yellow; streak, yellowish brown; fracture, uneven; veins and masses of white calc-spar with iron; very little visible pyrites; exterior coating of one-fourth of an inch of bituminous shining coal, with films of white calc-spar.

Black Band.—Colour black, compact and laminated, the deposition planes being bright and smooth; slightly oolitic on fractured surfaces; streak, liver brown.

Deep Seam (Halifax Co.)—The coal from this seam resembles that from the main seam, but is more compact and of a rather coarser appearance.

* Analysis made in London.

† Contains a little peroxide of iron.

‡ Phosphoric acid average of two determinations.

SECTION.

	Ft.	In.
Coal, coarse		2
„ good	3	7
Ironstone	1	1½
Coal, very good	3	5½
„ shaley (holing)		8½
„ good	3	9
„ coarse		11½
„ good	3	4
„ coarse	5	10
	22	11

In the dip workings, to which operations are now confined, the bottom bench is of good quality.

COMPOSITION.

	Slow Coking.	Fast Coking.
Moisture	·75	·75
Volatile combustible matter	20·34	25·82
Fixed carbon	68·50	63·02
Ash	10·41	10·41
	100·00	100·00
Theoretical evaporative power	9·39	8·64
Sulphur	·915	—
Specific gravity	1·330	—

Coke pulverulent; ash fawn-coloured.

This coal has been found well adapted for steam and iron working, and when mixed with the coal from the Foord pit makes an admirable steam coal.

ACADIA SEAM.—This seam is considered by many to be the westward extension of the main seam, the continuity being broken by heavy faults.

The following section is from the Air pit at the Intercolonial Company's Colliery :—

SECTION.

	Ft.	In.
Coal, good	5	9
Soft fireclay (holing)		3
Coal, good	5	6
„ hard grey		6
„ good	4	6
„ inferior	2	1
	18	7

In working 2 feet 6 inches of the top coal is left as a roof.

Coal compact, laminated and lustrous; deposition planes show much mineral charcoal; cleavage regular in two directions, giving the coal a cubical fracture; primary planes hold calc-spar and a few films of pyrites.

Composition.	Slow Coking	Fast Coking
Moisture	1·25	1·25
Volatile combustible matter ...	29·16	31·87
Fixed carbon	60·19	57·78
Ash	9·40	9·40
	100·00	100·00
Theoretical evaporative power .	8·21	7·92
Sulphur	1·625	
Specific gravity	1·330	—

Coke hard and compact; ash grey.

This coal has been largely exported to Montreal, and used for steam and domestic purposes, and also to some extent for gas. It is stated that the coal makes a marketable coke, but the writer has not seen any samples of it.

McBean Seam (Vale Colliery.)—This seam measures from seven to fourteen feet in thickness. At the point where the samples were selected it was 7 feet 2 inches thick, and perfectly free from any partings.

The coal is of a lustrous black colour, with a faint greyish tinge; lamina, fine and wavy; the primary and secondary planes intersect each other and the deposition planes a little obliquely, giving the broken coal a somewhat rhomboidal form; the primary planes have numerous films of white calc-spar with a trace of carbonate of iron; in one place films of selenite one-fourth inch thick occur; no visible pyrites; the whole of the coal is very compact in texture and uniform in appearance.

Composition.	Slow Coking.	Fast Coking
Moisture	·86	·86
Volatile combustible matter	22·95	25·87
Fixed carbon	62·95	60·03
Ash	13·24	13·24
	100·00	100·00
Theoretical evaporative power	8·90	8·23
Injurious sulphur	·85	
Specific gravity	1·379	—

This coal is well adapted for steam and domestic purposes, as it is entirely without clinker, the bars of the colliery furnaces being practically unaltered after four years firing. It has not been used for gas or coke-making as it is a free burning coal.

There are several other seams in the Eastern basin of the Pictou Coal-field which belong to an upper group of seams, which, although not yet opened, promise to be of superior quality for steam and metallurgical purposes.

The following table gives the composition of the ashes of several of the Pictou seams: —

	Main Seam	Deep Seam.	McBean Seam.
Iron peroxide ...	5·000	7·115	
Alumina	5·350	10·000	7·890
Sand and Clay, insol.	86·821	72·000	51·300
			33·200
Lime ...	1·200	1·212	·985
Magnesia	trace	2·650	·155
Manganese	·155	none	none
Sulphuric acid ...	·500	2·225	·785
Phosphoric acid ...	1·222	1·895	1·500
Chlorine	none	none	none
Alkalies	traces	traces	decided traces
	100·248	100·097	98·815

PRACTICAL TRIALS OF THE PICTOU COALS.

Two samples of coal from Pictou were tested at the American Navy trials in 1843. The coals must have been from the Albion Mines, working the main and deep seams, there being no others then opened, but it is not stated which seam they represented.

The results are from Mr. Walter Johnson's "Coal Trade of British America," page 131:—

	Moisture	F. C. M.	F. Carbon	Ash.	Furnace Ash	Lbs. of Steam from 212 degrs.	Theo. Evap. Power
No. 1.	2·56	27·06	56·98	13·38	·13·37	8·41	7·63
No. 2.	·78	25·97	60·73	12·50	1·206	8·48	8·33*

A trial of the Acadia Company's coal on one of the Government locomotives, made under the direction of Sir W. Logan, gave 7·21 lbs. of water evaporated from 212 degrees by each pound of coal. A similar trial of this seam as worked by the Intercolonial Coal Company, made under the same direction, gave 7·69 lbs.

From the foregoing analyses it will be seen that the coals from the Pictou district differ from those in Cape Breton in being less bituminous, with a larger percentage of ash, and very much less sulphur. The Pictou coals kindle readily, burn with a moderately long flame, and give a not very dense smoke, and, in general terms, may all be considered suitable for steam and domestic purposes, and some of them adapted for coke-making.

THE SPRINGHILL COAL-FIELD.

Only one seam has yet been opened in this district, known as the "Black Seam of the Springhill Mining Co." Through the kindness of William Hall, Esq., the manager of their colliery, a complete sample

* Theoretical evaporative power by Regnault's formula.

column of the seam was procured, from which the following set of analyses were made, forming an unusually full account of this very fine seam. The column was afterwards presented to the museum of the Geological Survey.

Section.	Ft.	In.
Top coal, a little coarse	1	7
Coal, good	1	2½
Fire-clay, parting		0½
Coal, good		8
„ „	1	6
Fire-clay, parting		6
Coal, a little coarse		9
„ good		11
Fire-clay, parting		1
Coal, good	2	2
„ „ with 1 inch soft coal		3
„ coarse		8½
	10	4½

Band, No. 1.—Bright compact coal of a deep black colour, with a few very thin bands of shaley coal, holding a little pyrites; a good deal of mineral charcoal, and very little calc-spar.

Band, No. 2.—Very similar to No. 1, with half-inch band of splint coal; in both these bands the primary and secondary planes are at right angles to the deposition planes, and inclined to each other at an angle of 70 degrees.

Band, No. 3.—Beautifully bright tender coal, very little visible pyrites; fracture hackly and uneven.

Band, No. 4.—Coal bright, with uniform pitchy lustre, little mineral charcoal; lower half of band compact, top rather friable; fracture irregular; a few films of pyrites in the lower part; top has both calc-spar and pyrites.

Band, No. 5.—Tolerably bright, with a good deal of mineral charcoal and pyrites; primary planes inclined to deposition planes at an angle of 65 degrees; secondary planes inclined to primary at angles of 65 to 70 degrees, and at right angles to deposition planes.

Band, No. 6.—Similar to last band, and with same system of cleavage, but brighter, and with several small layers of shaley coal.

Band, No. 7.—Uniform well-compacted coal, with moderate lustre, and very slightly laminated; a few thin layers of splint coal; little mineral charcoal; primary planes inclined to deposition at angles of 60 to 65 degrees; secondary similarily inclined to deposition, and nearly at right angles to primary planes; a few very thin films of pyrites on both planes.

Band, No. 8.—Coal bright and rich, with much mineral charcoal; one inch band of soft charcoal and dirt in the centre, with thin threads of shale and pyrites; the rest of the band contains no pyrites.

Band, No. 9.—Coal a little coarse, with dull lustre; much pyrites with thin layers of pyritous shale efflorescing on exposure; cleavage irregular.

Composition of Black Seam.

	Band, No.	1.	2.	3.	4.	5.	6.	7.	8.	9.
Moisture		·98	·76	1·21	·30	·63	·90	1·34	·56	·41
Volatile Comb. Matter.	Slow Coking	30·81	32·22	33·81	29·19	28·90	31·56	33·64	30·27	28·54
	Fast Coking	31·75	36·12	37·25	32·66	33·84	35·17	35·94	33·88	30·47
Fixed Carbon.	Slow Coking	60·73	60·91	63·13	67·95	65·16	60·59	59·86	60·89	63·63
	Fast Coking	57·82	57·01	59·69	61·18	60·22	59·98	57·56	57·28	61·70
Ash		7·45	6·11	1·85	2·56	5·31	3·95	5·16	8·28	7·12
Sulphur		·85	·56	·79	1·21	1·85	·89	1·19	2·65	2·25
Specific Gravity		1·31	1·30	1·28	1·27	1·29	1·28	1·29	1·33	1·32
Theoretical Heat Power.	Slow Coking	8·33	8·10	8·65	9·28	8·92	8·32	8·21	8·35	8·99
	Fast Coking	7·95	7·65	8·20	8·83	8·30	8·20	7·88	7·75	8·54

Coke bright and tolerably compact; ash of average sample, grey with tinge of pink.

The following ultimate analysis of the coal is by Dr. Percy :—

Carbon	78·51
Hydrogen	5·19
Oxygen } Nitrogen }	9·98
Sulphur	1·12
Ash	5·20
	100·00

One noticeable point in this seam is the irregular courses of the partings and the consequent heavy percentage of slack coal. The demand for this coal is so large that the colliery is unable to meet it. Its sales are confined to steam and domestic uses, for both of which it is admirably adapted, but, theoretically speaking, it should be a fair gas coal. It resembles in composition and appearance the Newcastle Hartley coals. It is stated that it has been practically tested for coke, but no positive information about the results is available.

NEW BRUNSWICK COAL.

The productive coal-measures in this province extend over an area of no less than 1,900 square miles, but, unfortunately, there are only a few

thin seams known to exist in it, the thickest of which measures 22 inches. As the coal in many places lies quite horizontal and a few feet below the surface, it is won by stripping. The coal is of the fat bituminous coking variety, of excellent quality, and finds a ready market in the province.

At Lepreaux, twenty-five miles west of St. John, a bed of anthracite has been recently discovered in measures which belong, presumably, to the Devonian age. The coal has a very promising appearance, and finds a good market in St. John. Should it prove not to be merely a metamorphosed carbonaceous shale, with a varying percentage of ash but a persistent workable bed of coal, it will prove very valuable, as large quantities of anthracite are imported from the United States for heating houses and foundry purposes.

THE COALS OF THE NORTH-WEST TERRITORY AND BRITISH COLUMBIA.

An immense space, both geological and geographical, has to be passed over before coal is again met with, but from longitude 100 degrees to 117 degrees west, and from the International Boundary parallel to the 60 degrees of latitude, the officers of the Geological Survey have everywhere found lignite, and in the following sketch their reports have been largely used.

Along the International Boundary Line, and in the Qu'appelle River Valley, the lignites appear to be of Tertiary age. At the Dirt Hills Mr. R. Bell noticed, in one short section, the outcrops of four seams measuring six, four, three, and five feet respectively.

Some of the beds are made up of the carbonised trunks and branches of trees (mostly of coniferous species) and comminuted plant remains, without any visible mixture of other matter as sand or clay. In some beds there is much earthy impurity, and these show the forms of the plants much more clearly. Dr. Dawson remarks as follows, on one of the Dirt Hill seams:—"The material has the aspect of a compressed mass of roots, branches, and other vegetable fragments, with a little mineral charcoal and occasional pieces of yellow resin. The roots and branches are flattened in the state of lignite and mixed with vegetable debris as if accumulated in a swamp. The mineral charcoal shows a structure resembling that of cypress, sequoia, and thuja. Taken in connection with other collections it would appear that in the period of the Tertiary lignites the plains east of the Rocky Mountains bore dense forests of coniferous trees, some of them of types now found on the west coast, and enjoyed a more humid and equable climate than at present."

Analysis of coal from Dirt Hills, by Mr. C. Hoffmann. Coal rather friable; splits in laminæ; colour almost black; fracture sub-conchoidal, and having a resinous lustre; streak almost black. The specimen was soiled with clay.

	Slow Coking.	Fast Coking.
Moisture	17·53	17·53
Volatile combustible matter	34·61	35·17
Fixed carbon	40·24	39·38
Ash	7·62	7·62
	100·00	100·00

Coke pulverulent; ash pale brownish grey.

"None of these lignites are as good as the brown coals from the Jaskatchewan, but resemble more closely those collected from the Souris Valley by Mr. G. M. Dawson. On account of their rapid disintegration they should be used as soon as possible after being mixed."

Mr. Selwyn, Director of the Survey, speaking of his explorations in the North Jaskatchewan, says:—"There can be no doubt that in the region west of Edmonton, bounded on the north by the Arthabasca River, and on the south by the Red Deer River, there exists a vast coal-field, covering an area of not less than 25,000 square miles; and beneath a large portion of this area we may expect to find workable seams of coal, at depths seldom exceeding 300 feet, and often very favourably situated for working by levels from the surface." And he considers the lignites cropping for two hundred miles along the banks of the North Jaskatchewan as possibly of the Cretaceous age. The lignites form beds from six inches to twenty feet in thickness; some are quite compact and pure, others again are rendered valueless by partings of sand and clay. No work has yet been done to prove the regularity of the seams, a point which is so important in the development of the recent coals.

In this connection a few words on the coals worked in Colorado, Wyoming, and Utah, in the southern continuation of that vast and widespread coal-field extending "from the shores of the Arctic Ocean for thousands of miles along the Rocky Mountains" may not be out of place.

The largest of these coal-beds is in Bear River, Utah, and is 27 feet thick. These beds are remarkably free from impurities, there being frequently 10 feet of clean coal, of brilliant lustre, perfectly free from visible foreign matter. Iron pyrites is frequently present in thin films, but seldom to an injurious amount. The coals with few exceptions will not make a merchantable coke, and are liable to rapid disintegration on exposure to rain and sun. As shown by their analyses they hold

notable percentages of water, and hence are not suited to blacksmiths' work and furnaces. The coals answer well for locomotives and domestic use, kindling readily, and burning with a yellow flame and little smoke. The wonderful uniformity and persistence of these coals over so vast a region, and their superiority over the foreign varieties, known by the same name, would entitle them to a distinctive appellation. The containing measures and the seams show plainly their deposition on the shores of fresh water basins; consequently the seams are found of very irregular thickness, frequently in a few yards varying from a few inches to fifteen feet, and require the most enlightened systems of mining.

Composition of Lignites from the North Jaskatchewan:—

	Slow Coking.	Fast Coking
Moisture ...	7·82	7·82
Volatile combustible matter	31·35	38·00
Fixed carbon	54·97	48·25
Ash (red)	5·86	5·86
	100·00	99·93

Coal bright black; fracture angular, compact; gives dark brown colour to solution of potassium hydrate.

Average of six samples from various seams on the same river, by slow coking:—

Moisture	10·34
Volatile combustible matter ..	29·90
Fixed carbon . . .	53·27
Ash ...	6.49
	100·00

Passing to the province of British Columbia, a very abnormal development of coal-bearing measures is found.

The coal-fields of this district have been touched on first, by Mr. Banerman, of the International Boundary Commission, and Dr. Hector;* also by Dr. Forbes and Messrs. Palmer, Bigbie, and Pemberton. Dr. Robert Brown also published a valuable paper on the Vancouver Island Coal Fields.†

On the main land there are beds of lignite at Quesnel Mouth, and Chilcotin, and the mouth of the Fraser River, in strata, probably of the Tertiary age. No detailed accounts of the extent or value of the beds has yet been published. There are many other places where

* *Vide* Proceedings London Geological Society.

† *Vide* Proceedings Edinburgh Geological Society. 1868 9.

coal is reported to be found, but practically the field is yet unexplored and unoccupied.

Passing to the eastern shore of Vancouver's Island, an extensive and valuable development of coal measures is found.

There are two chief districts—that of Comox, forty miles long and thirteen broad; and that of Nanaimo, sixteen miles long and six wide. There has, however, really been so little done to develop the extent of the coal-fields that the above estimates of Mr. Richardson are purposely made on the small side.

The following short section is from the area of the Union Coal Mining Company, near Comox Harbour.

	Ft.	In.
Drab and grey sandstones	45	0
Coal, good	4	6
Shales and sandstones	15	0
Coal, good	5	4
Grey sandstones	10	0
Coal, good	6	0
Grey and drab sandstones	3	10
Coal, good	10	0
	99	10

The gradual diminution of the thickness of the sandstones, and the corresponding increase of the coal beds in the above section is worthy of notice. There are many other seams exposed, but their relative positions are unknown.

Similar seams are met in the Nanaimo coal-field, and are worked to some extent for local use and exportation to the United States. The chief trouble met in working the seams of both districts is that they thin out, become unproductive, and form isolated masses, possibly owing to a drift origin. These seams are also met with at Fort Rupert on Queen Charlotte Sound, Quatsino Sound, and Koskeemo on the western shore.

American and Canadian palæontologists agree in referring these coal measures to the Chico or Upper Cretaceous group, or to the horizon nearly of the white chalk of the English series.*

The coals from these strata are not lignites, but *true bituminous coals*, frequently yielding a coke having a black powder, and scarcely colouring solutions of potassium hydrate.

* Geological Survey, Canada, 1872–3, p. 75. Geological Survey, California, Vol. II., preface, xiv.

Composition of Coal Union Mine, Comox, by Mr. C. Hoffmann. Geological Survey of Canada:—

	Slow Coking.	Fast Coking.
Moisture	1·70	1·70
Volatile combustible matter	27·17	32·36
Fixed carbon	68·27	63·08
Ash	2·86	2·86
	100·00	100·00

Coke compact and vesicular; ash light grey.

The following is the average composition of seven samples from the districts of Comox and Nanaimo:—

	Slow Coking.	Fast Coking.
Moisture	1·47	1·47
Volatile combustible matter	28·19	32·69
Fixed carbon	64·05	59·55
Ash	6·29	6·29
	100·00	100·00

Mr. R. Brown, in his paper on the North Pacific Coal-fields, gives eight ultimate analyses of Vancouver Island coals, of which the following is an average:—

Carbon	67·144
Hydrogen	5·530
Oxygen	10·623
Nitrogen	1·279
Sulphur	·813
Ash	14·642
	100·061

The same writer, speaking of this coal, says:—"The coal itself is light, tolerably compact, and not unlike some of the best varieties of English and Welsh coals in appearance. It is used by Her Majesty's ships, and all colonial and other steamers plying on the coast. It is highly valued as a domestic fuel in San Francisco, and gas of fair illuminating quality is manufactured from it in Victoria."

QUEEN CHARLOTTE ISLANDS.

The existence of coal in these islands has been known for a long time, and mines were opened at Cougitz about twelve years ago. At this point the coal measures appear to occupy a strip of land on the shore twenty miles long and five broad. Coal seams have been found in other localities, but no work has yet been done to test their values. The coal seams vary in thickness from 2 feet 6 inches to 6 feet, but they appear to be subject

to the prevailing drawback of the modern coals of America, viz., a tendency to thin out or become replaced by carbonaceous shale.

The coal is all anthracite, and until recently was regarded as of Palæozoic age. Mr. Richardson's discoveries, however, appear to have proved that it belongs to a horizon high up in the Jurassic, or low down in the Cretaceous.

Composition by fast coking of two samples from Skidgate :—

	I.	II.
Moisture	1·60	1·89
Volatile combustible matter ...	5·02	4·77
Fixed carbon	83·09	85·77
Sulphur	1·53	·89
Ash	8·76	6·69
	100·00	100·01

The writer would have had much pleasure in extending his remarks on the coals of British Columbia and the North West Territory, but is afraid that he has already trespassed too much on the indulgence of his readers. The analyses, etc., of the Nova Scotian coals represent a good deal of work, but the writer will feel repaid if, through the valuable proceedings of the Institute, he is enabled to give any information about so important an item in the resources of England's nearest colony.

The Canadian Government are using every legitimate method of attracting desirable immigrants to the North West Territory, and in this connection, as well as that of the Pacific Railway, which is slowly advancing to the west, the existence of coal in such widespread deposits is of great importance.

In British Columbia there are indubitable signs of important deposits of iron, gold, and silver, so that her coal beds acquire a value for manufacturing and metallurgical purposes, in addition to their usefulness for marine and domestic fuels.